



REMARKS

The present amendment is submitted in response to the Office Action mailed June 26 2001, which set a three-month period for response. File herewith is a Request for a Two-Month Extension of Time, making this amendment due by November 26, 2001.

Claims 1 through 25 are pending in this application.

In the Office Action, claims 1 through 25 were rejected under 35 U.S.C. 103(a) as being unpatentable over U.S. Patent No. 5,053,617 to Kakizaki et al and further in view of U.S. Patent No. 4,631,402 to Nagatsuma et al.

The Applicants respectfully disagree that the cited reference combination makes obvious or suggest the present invention as defined in the claims.

The primary reference to Kakizaki et al discloses a measuring instrument for determining the electrical field, which comprises an optical portion and an electronic analysis unit. Kakizaki mentions the use of several sensor crystals.

Regarding the rejection of claims 1-6, 9, 10, 17-20, and 25, the use of a Pockel cell comprising a single sensor crystal, an analyzer, a polarizer, and a diaphragm is well known in the art. With this optical structure, the electrical voltage (not the electrical field) cannot be measured with the necessary accuracy for the following reasons:

- a) The unit to be measures is voltage, not an electric field. The present invention measures voltage;
- b) The voltage typically lies in the range of 100 kV to 800 kV and, as a result, is labeled as high voltage. A Pockel cell cannot be used to measure a

high voltage on the basis of the dielectric strength, according to the prior art. The present invention can measure the high voltage in the given magnitude;

c) The required measure accuracy lies in the magnitude of 0.1%. The known process of Kakizaki cannot fulfill or achieve the amplitude accuracy from 0.1% for measuring a high voltage, which is substantially independent from interference fields, since foreign fields affect the measuring accuracy in practical use in a distributing board. The present invention uses, therefore, sensory crystals, which, based on their crystal cut and the local distribution (either linear over the measuring section and optionally with various sensory crystal lengths for weighting according to the Simpson formula) perform a vectorial integration of the electrical field strength for the determination of the current voltage by definition, approximating a summation. This characteristic is essential for the technical realization and the necessary accuracy. The cited references do not have these features.

d) Nagatsuma et al show the use of three sensor crystals in Figure 10. The details in the description relates to the widening or increase of the frequency area. A use of the frequency area up to the 100 kHz area is uninteresting and irrelevant in the energy technology application, since only frequencies up to 100 Hz with a typical 0.1% amplitude accuracy and up to 3 kHz, with typically 5% accuracy are needed. Nagatsuma provides that in Figure 10, the electric field lies longitudinally (that is, in the transmission direction) as well as transversely (that is, perpendicular to the transmission direction).

Regarding the transversal modulation, the principal of frequency widening, as described by Nagatsuma, functions only when not longitudinally modulating (that is, electric field- and transmission direction-parallel), rather than transversely modulating. IN this case, no integral of the field strength along the optical integration direction occurs so that, by definition, an electric field, not voltage can be measured. The present invention measures an electric voltage.

Regarding longitudinal modulation, the crystal length is without effect on the above limiting frequency. The crystal length is exclusively dependent on the geometric dimensioning of the light-impacting surfaces (and from physical material parameters). The longitudinal modulation is essential, however, to the voltage measurement, since only in this manner, an integration of the electric field strength is possible for determining the electric voltage, without the effect of foreign fields, in order to stop the given classification accuracy. Figure 10, therefore, is not useable for measuring voltage, rather only for measuring a local, electric field strength with increased frequency. The process of the present invention fulfills the requirements for measuring the electrical voltage in the technically interesting frequency area.

e) Depending on the temperature dependency of the optical material parameter in the percent area, a compensation of the affect of the temperature is necessary in order to achieve the amplitude accuracy in the 0.1 % range in a temperature range of -40° C to +80° C for industrial uses.

In addition, Kakizaki uses the non-linear quality of the sinusoidal transmission characteristic of the polarimetric analysis, in order to be able to

determine a temperature-conditional adjustment of the working point with the aid of the harmonic content. Further, the temperature-dependent double refraction, described in Kakizaki, column 3, lines 43 and on, is used with the temperature averaging for the measurement of the voltage. This process has the disadvantage that the static scattering part of the temperature-dependent linear double refraction overlies, or superimposes, the net efficiency, namely, the field-induced linear double refraction. In particular, the static, scattered portion of the linear double refraction increases with the number of crystals. Thus, the net efficiency is superimposed through the interference effect, which affects the same physical operating mechanism. Therefore, according to the principles of Kakasaki, a precise temperature recognition with a strong temperature-adulterated information signal results.

In the present invention, these disadvantages are avoided. The temperature-affected measuring channel is not completed by a measuring signal-adulterated, temperature-dependent element. In addition, a second, separate temperature-measuring channel is used, in order to acquire the temperature information. In this connection, it is also possible to reconvey the temperature determination in the second measuring channel through the temperature-dependency induced element onto the optical activity (circular double refraction). Therewith, the physical operating principles (Pockel's Effect on voltage measurement, temperature-dependent optical activity on temperature determination) can be uncouples from one another with opposite effects. Thus,

with the present invention, it is now possible to measure the temperature with the required accuracy and reproducibility.

Nagatsuma does not compensate for the temperature effects on the sensor crystals and states that these crystals have “desirable temperature characteristics” (column 8, line 47). In Figure 9, a temperature dependency between 10° C and 70 ° C at approximately 1% can be seen. In the area interesting for purposes of industry (between -40° C and +80°), a temperature drift of approximately 2% consequently can be calculated. This is too large for the required accuracy in the region of 0.1% at the factor 20. Compensation is not provided in Nagatsuma.

The present invention compensates for the temperature effects and is thus advantageously adjustable.

Claims 7, 8, 21, and 24 of the present application relate to the electronic portion of the invention. It is correct that in the state of the art, it is known to use an AC-component detector, a DC-component detector, and a divider for signal normalization.

For measurement under accuracy requirements in the area of 0.1%, the accuracy of the electronic components can no longer be overlooked. Commercially available divider components have an inaccuracy in the division of about 1% in the areas of dynamics and temperature. This is within typical limits for the required function of the invention for voltage measurement (0.1% accuracy of the entire measuring structure).

With the present invention, a common increase in accuracy is achieved by the following characteristics, which are essential for the entire functioning of the voltage-measuring device:

1) The calculated inaccuracy of the known methods is eliminated, in which a reaction in the represented type and manner negatively affecting the calculated inaccuracy is principally avoided;

2) The temperature dependency of the electronic components is minimized through the availability of the high precision reference source;

3) The subsequent wiring expenditure is minimized, since the known DC-portion rests constantly on the reference voltage after the normalization of the present invention.

These features are neither shown nor suggested by the cited references. The above advantages and features are essential to the voltage-measuring device of the present invention.

Regarding the rejection of claims 11, 12, and 14-16, the material for use of the Pockel's effect is widely known from the literature. However, the present invention combines advantageously the crystals from the Group 43m, in particular, $\text{Bi}_4\text{Ge}_3\text{O}_{20}$ (or $\text{Bi}_4\text{Si}_3\text{O}_{20}$) for temperature determination (optical element 16), so that primarily a two-channel measurement of electrical voltage by the Pockel's-effect and temperature compensation through the optical activity can realize the above-described advantages.

In conclusion, the present invention differs from the cited combination of references in a number of characteristics that provide to the invention the ability

to measure a high voltage under consideration of the accuracy defined in the appropriate steps. These features include the following:

a) The integration of the field strength: An important aspect of the present invention is that the inventive process uses a plurality of sensor crystals which approximate the field strength integral for determining the electric voltage with a sufficiently accurate summation, whereby the voltage to be measured is a "high voltage" (typically over 100kV). With smaller voltages, the process also functions, but does not exhibit the constructive advantages discussed above. The obtained integration accuracy specifically is under 0.1%.

b) Compensation for temperature effects: On the optical side, a divided signal pad OS_3 is used, in order to make possible a temperature measurement by means of a temperature dependent element 16 in connection with the information signal path OS_2 (see Fig. 3). Advantageously, the specific measuring signal is not adulterated by measurement of the temperature, which is the case in the cited art. In addition, two independent physical effects for the compensation process are used (as defined in claims 1 and 2). Thus, the danger of negative effects on both channels is avoided.

c) A control normalization circuit: The present invention avoids the common disadvantages of the available analog dividers (in the amount of 1%), in which the normalization is essentially reconveyed on a controlled multiplication and therefore, highly accurate alternative elements can be used. The superimposition of high frequencies in real time for protective use is made possible by the present invention. Other, known normalization circuits, such as

those described in the cited references, are principally bandwidth limited and/or inaccurate, and therefore, are unsuitable for the measuring purposes of the present invention.

For the reasons discussed in detail above, the Applicants respectfully submit that claims 1 through 25 are patentable over the cited combination of references to Kakizaki et al and Nagatsuma et al, since these references, when viewed together, fail to suggest to the practitioner the features of the present invention as claimed.

In light of the foregoing argument in support of patentability, the Applicants respectfully submit that this application now stands in condition for allowance. Action to this end is courteously solicited. Should the Examiner have any further comments or suggestions, the undersigned would very much welcome a telephone call in order to discuss appropriate claim language that will place the application into condition for allowance.

Respectfully submitted,

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